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# MARKET STRUCTURE AND INDUSTRIAL PERFORMANCE: MEASURING AND ANALYZING VERTICAL COORDINATION



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Abstract

The effects of market structure on industry performance are well documented. We examine vertical coordination as a structural variable, analyzing its impact on industrial performance. We develop a measure of vertical coordination incorporating input-output relationships and mechanisms which transfer administrative control. Empirically examining the food processing industries, our findings suggest that the industries with higher degrees of vertical coordination export less but achieve greater profits.

# MARKET STRUCTURE AND INDUSTRIAL PERFORMANCE: MEASURING AND ANALYZING VERTICAL COORDINATION

The effects of industry structure on industrial performance measures are well developed in literature. However, recent concerns have arisen regarding the impacts of technological developments on the future structure and performance of agriculture. Here within, we examine vertical coordination as a market structure variable and relate it to technology as a cause and market performance as a consequence.

Numerous studies have examined transactional inefficiencies brought about by such events as new technological innovations and the subsequent changes in vertical governance structures (e.g. spot markets, contracts, and integration). The net is a shift in coordination of production towards nonmarket institutions (Schrader). For instance, the percentage of total farm output produced under either contractual arrangements or vertically integrated firms increased from 25 percent in 1960 to 31 percent in 1980 (Marion pg 15). Current advances, primarily in biological and information technologies, are expected to further affect the institutional means by which the food and fiber sector coordinates its vertically interdependent activities.

Vertical coordination captures the market and nonmarket administrative structure of control between vertically interdependent firms. However, past research has not systematically examined vertical coordination as a market structural variable.

In this paper we propose a measure of vertical coordination that incorporates the entire spectrum of vertical arrangements that transfer control. The resulting index of vertical coordination augments research efforts to examine the impacts of structure on industry performance.

## Vertical Governance Structures

Traditional economic thought on vertical integration centered upon the ownership of assets in neighboring stages of production, allowing for complete control over the entire production process. However, control over adjoining stages of production need not be accomplished through direct ownership of assets. Increased attention has been given to the role of contractual and implicit arrangements in vertical relationships. Governance structures or contractual ties can range from virtually no control to those affording complete control. Indeed, Schrader suggests "the effective difference between contracting and integration is not a difference in coordination."

In their classic study Mighell and Jones (pg 1) define vertical coordination as "the general term that includes all the ways of harmonizing the vertical stages of production and marketing. The market price system, vertical integration, contracting, and cooperation singly or in combination are some of the alternative means of coordination." They (pg 7) define an economic stage of production as "any operating process capable of producing a salable product or service under appropriate circumstances." Marion (pg 60) further defines a stage as "any value-added process, whether a change in location, time, or form of the commodity. It is any step that takes the commodity closer to final consumption."

Both Coase and Williamson (1975, 1979) have examined the factors affecting the organization of production in a market-hierarchies framework. In this framework, the criterion for organizing production is the minimization of production and transaction costs (Williamson, 1979). Transaction costs are the costs associated with the exchange of goods or services. However, Williamson suggests that transaction costs are the primary force behind vertical coordination, stating "if transaction costs are negligible, the organization of economic activity is irrelevant."

Structural and environmental factors which affect transaction costs include uncertainty, complexity and frequency of transactions, thin markets, and idiosyncratic investments. Changes in one or more of these factors may lead to problems of bounded rationality, opportunism, and information impactedness. The institutional means of vertical coordination are dependent upon the degree to which bounded rationality, opportunism, and/or information impactedness occur.

Williamson (1979) discusses a theoretical scheme of governance structures to examine these problems by identifying three classes of contracts; classical, neoclassical, and relational. Classical contracting is contingent-claims, which entails consideration of all future contingencies regarding the supply of production. The nature of the agreement is generally formal (i.e. written) with the consequences of nonperformance known ex ante. In essence, classical contracts are based on a set of legal rules with formal documents and self-liquidating transactions. Neoclassical contracts generally involve longer-term arrangements that do not cover all future contingencies. Trilateral governance structures (i.e. arbitration) are usually established to maintain needed flexibility. Relational contracts entail "adjustment processes of a more thoroughly transaction-specific, ongoing administrative kind" than that of either classical or neoclassical contracts. Relational contracts consider the "entire relation as it has developed through time."

In this scheme, increases in transaction complexity, frequency, and uncertainty, accompanied by idiosyncratic investments, shift the governance structure from classical to neoclassical to bilateral and finally to unilateral (integration) relational contracts. Clearly, under this progression, one party acquires increasing administrative control.

Williamson's governance contract structure provides theoretical insight into the structure of vertical coordination. In an empirical analysis of the food and fiber system, Mighell and Jones identified three general types of contracts: market specification, production management, and resource providing. These parallel Williamson's theoretical treatment of vertical coordination in terms of transferring administrative control.

In market specification contracts the supplier transfers part of the risk and management functions to the contractor. The firm is certain of its market and the basis for computing the price for its production. Management is transferred to the contractor only to the extent that the decision of what to produce along with when and where the product is to be marketed.

Production management contracts are similar to market specification contracts but differ in that the contractor has an increased role in production management. Contractor management usually takes the form of cultural and resource specifications. This is important when the quality of production is of critical concern. This may occur with new firms or when a new technology is involved.

Resource providing contracts are the closest to vertical integration. The contractor not only provides a market for the production, but also is a major provider of inputs into the production process. Under this form of coordination the contractor assumes additional risks of losing his investment inputs and therefore monitors production more closely.

It is apparent that many factors influence the structure of vertical coordination and that there are several governance (institutional) structures organizing production. However, not so apparent is the impact upon efficiency. In a vertical system, each stage is interconnected with adjoining stages and each stage is vital to the efficacy of the entire system. If any one stage is inefficient, the whole system is ultimately adversely affected, being less efficient and thus less competitive.

The magnitude of vertical interdependence concomitant with the vertical coordination governance structure, not the degree of vertical integration, makes industries competitive (Eckard). Examining the auto industry's vertical structure, Eckard found that the Japanese rely on more contractual arrangements than in the U.S., which is more integrated. He concludes that this contractual vertical structure has improved the efficiency of Japanese industry.

These governance structures, either spot market, contractual, or integration, are an important dimension in the vertical structure of an industry or sector. In essence, for an industry to be competitive, it must minimize its vertical up-stream and down-stream organizational (transaction) costs. To analyze these costs and thus, competitive performance, a measure of vertical coordination is needed.

The recognition of these governance structures implies a broad range of vertical relationships or coordination. Variables which consider both the ownership and contractual relationships of vertically interdependent firms or industries will more accurately measure vertical coordination. A measure of vertical coordination should capture the direct (ownership) and indirect (contractual) relationships that reflect interdependency among firms and industries, along with the magnitudes of the vertical interdependencies in an input-output context.

Empirical research has examined vertical coordination primarily in the context of vertical integration. Studies by Adelman, Laffer, and Tucker and Wilder used variations of the value-added to sales ratio to calculate an index of vertical integration. However, there are two significant drawbacks to this measure. First, the ratio is influenced by more than vertical interrelationships, primarily profitability. Second, the value of the ratio is dependent upon the position of the firm in the production process. Therefore, this ratio has limited empirical value in the comparison of different industries.

A second measure of vertical integration examines the linkages between industries through production functions. Maddigan advances this alternative view which considers the interdependence between firm's or industries' outputs. In this context, the measure focuses on the linkages created by firms between industries across markets. These linkages can be captured by aggregate production functions and are expressed by physical input-output coefficients.

## A Measure of Vertical Coordination

To empirically examine the linkages between vertically interdependent industries, it is first necessary to develop a measure of vertical coordination (VC). Such a measure must satisfy two criteria; it must have a foundation in economic theory and be measurable (Adelman). A starting point for measuring Vertical Coordination (VC) is Maddigan's Vertical Industry Connection (VIC) index.

This index exploits the interactions of the Leontief input-output model. Briefly, the Leontief model is based upon the firm. It is assumed each firm maximizes profits subject to its production function and final demand for its output. With the necessary and sufficient conditions satisfied, an optimal solution vector of inputs for each firm is determined. The optimal level of output for each firm is then obtained by substituting the solution vector of inputs into the firm's production function. The whole system of firms attains equilibrium when the value of the outputs supplied by each industry equals the demand for inputs by each industry and by final consumers.

It is assumed each firm is characterized by a linear expansion path independent of the scale of operations. A less severe assumption is that firms have linear expansion paths over the relevant range of production. Therefore, the model describing the relative level of interaction between industries can be expressed in an input-output matrix by the consistent aggregation over products and firms. In the Leontief framework, each $x_{ij}$ in the input-output transactions matrix X is the optimal value of industry i's output used as an input by industry j.

To examine the vertical relationship between interdependent industries, the input-output transactions matrix is constructed for the relevant economic sector(s). The S.I.C. (Standard Industrial Classification) scheme may be used to classify or group firms into industries. For example, four digit S.I.C. industries including those within the production agriculture sector (S.I.C. 0111 to 0291) and the food and fiber manufacturing sector (S.I.C. 2011 to 2099) could be used to examine linkages between farms and downstream food processors and manufacturers.

The input-output transactions matrix is manipulated to form the foundation of the VC index. Two matrices, A and B, are created. In matrix notation:

$$A = I - [x_{ij} / (z_j - x_{jj})] + [y_{ij}]$$

and

$$B = [x_{ij} / (z_i - x_{ii})] - [y_{ij}] - I$$

where;

$I$ = identity matrix, r x r,

$x_{ij}$ = the value of the $i^{th}$ industry's output used as an input to the $j^{th}$ industry; $i, j = 1,...,r$,

$z_j$ = total value of the output of industry j; $j = 1,...,r$,

$y_{ij} = [x_{ii} / (z_i - x_{ii})]$ if $i = j$; 0 if $i \neq j$; $i, j = 1,...,r$.

Each element of matrix A, $a_{ij}$, shows the percentage of the value of industry j's net output contributed by industry i. Each element of B, $b_{ij}$, shows the percentage of the value of industry i's output used as an input to industry j. In short, matrix A is the up-stream industry connections and matrix B is the down-stream industry connections. Inputs are negative as values used in production and outputs are positive.

In order to calculate VC at the food industry level, two matrices are defined for each food and fiber industry (four digit S.I.C., ie. 2011 to 2099). Each industry will be characterized by matrices $C_K$ and $D_K$, where industry k has an input relationship with industry i and an output relationship with industry j. The division of industry k with its interdependent industries is determined by the flow of net production. These matrices are constructed using the rows and columns of matrices A and B, specifically, the columns of A and the rows of B. Matrices $C_K$ and $D_K$ are;

$$c_{ij} = a_{s(i)s(j)}$$

and

$$d_{ij} = b_{s(i)s(j)}$$

where;

s(i) = one of the industries with which industry k is associated, indexed by i; $i = 1...n$ ($n \leq r$),

$c_{ij}$ = the percentage of the value of industry s(j)'s net output contributed by industry s(i),

$d_{ij}$ = the percentage of the value of industry s(i)'s net output used as an input to industry s(j).

To complete the measure of vertical coordination, a spectrum of vertical control ranging from no control to absolute control must be incorporated. To do this we propose segmenting differing types of contracts into a systematic cardinal measure of coordination. This is a subjective approach because data are not available which quantify the transfer of administrative control.

Instead of a continuous line of vertical control, a discrete line of five partitions is used to represent the spectrum of administrative control (see Figure 1). From the left moving right the line measures increasing degrees of administrative control by the contractor or integrator. The initial point represents open market transactions (spot market) then progresses, using Mighell and Jones' terminology, to market specification contracts, production management contracts, resource providing contracts, and finally ownership (integration). The cardinal measure assigned to each partition, representing increasing administrative control (moving from spot markets toward ownership), is then inserted into the functional formulation for a measure of Vertical Coordination.

| Type of Contract: | spot market | specification | production management | resource providing | ownership |
|---|---|---|---|---|---|
| Cardinal Value: | 0.0 | 0.25 | 0.5 | 0.75 | 1 |

Figure 1. Cardinal Measurement of Vertical Coordination.

To capture contractual interactions, matrices $E_K$ and $F_K$ are created. Each $e_{ij}$ represents the measure of administrative control for industry k with the up-stream industry i. Similarly, $f_{ij}$ represents industry k's administrative control with down-stream industry j. The values for matrices E and F are equal to the sum of the products of the percent of each transaction type and its cardinal value between industry i and j. The values for $e_{ij}$ and $f_{ij}$ may be expressed as;

$$e_{ij} \text{ and } f_{ij} = \sum_{g=1}^{n} \sum_{h=1}^{5} C_g M_{gh} T_{gh}$$

where;

M = cardinal value of transaction type (see Figure 1),
T = percent of production coordinated by each transaction type,
C = commodity C's percentage of industry i's output,
g = number of commodities produced in each industry,
h = type of contract (see Figure 1).

With matrices C, D, E, and F constructed, the variable VC may be calculated. Using matrix notation, the VC for industry k is defined as,

$$VC_k = 1 - [1 / \prod_{i=1}^{i=n} (C^i)^T(C^i)(D_i)(D_i)^T(E^i)^T(E^i)(F_i)(F_i)^T]$$

where;

$T$ = transpose,
$n$ = the number of industries in which industry k operates,
$C^i$ = column i of industry k's input matrix,
$D_i$ = row i of industry k's output matrix,
$E^i$ = column i of industry k's administrative control matrix,
$F_i$ = row i of industry k's administrative control matrix.

The functional form of VC has several desirable properties:

1. VC increases (decreases) when an input industry becomes relatively more (less) important by accounting for a larger (smaller) percentage of the total value of output of another industry.
2. VC increases (decreases) when relatively more (less) of the output of an industry is used as an input to another industry.
3. VC increases (decreases) as an industry increases (decreases) its number of vertical interactions with other industries.
4. VC increases (decreases) as an industry exercises increased (decreased) administrative control.
5. The range of VC is between 0 and 1. Thus, VC can be treated as an index number.

## Results

To empirically examine the vertical coordination linkages between the food manufacturing industries and farm output sectors, we specified progressively comprehensive forms of the vertical coordination index. The first, AVC, measures the food industries' degree of up-stream administrative control. The second measure, VC1, captures up-stream linkages. The third, VC2, measures up-stream linkages plus the degree of vertical administrative control. The fourth measure, VC3, incorporates the components in VC2 plus the industry's down-stream linkages. Due to limited data availability, the degree of down-stream administrative control was not incorporated into the calculation of the vertical coordination indices.

The value of information contained in different measures of vertical coordination is illustrated in Figure 2. It is clear that the degree of vertical coordination increases as the amount of information captured by each index increases (moving from VC1 to VC3). For example, in the sugar, poultry, and fruit and vegetable industries, the importance of

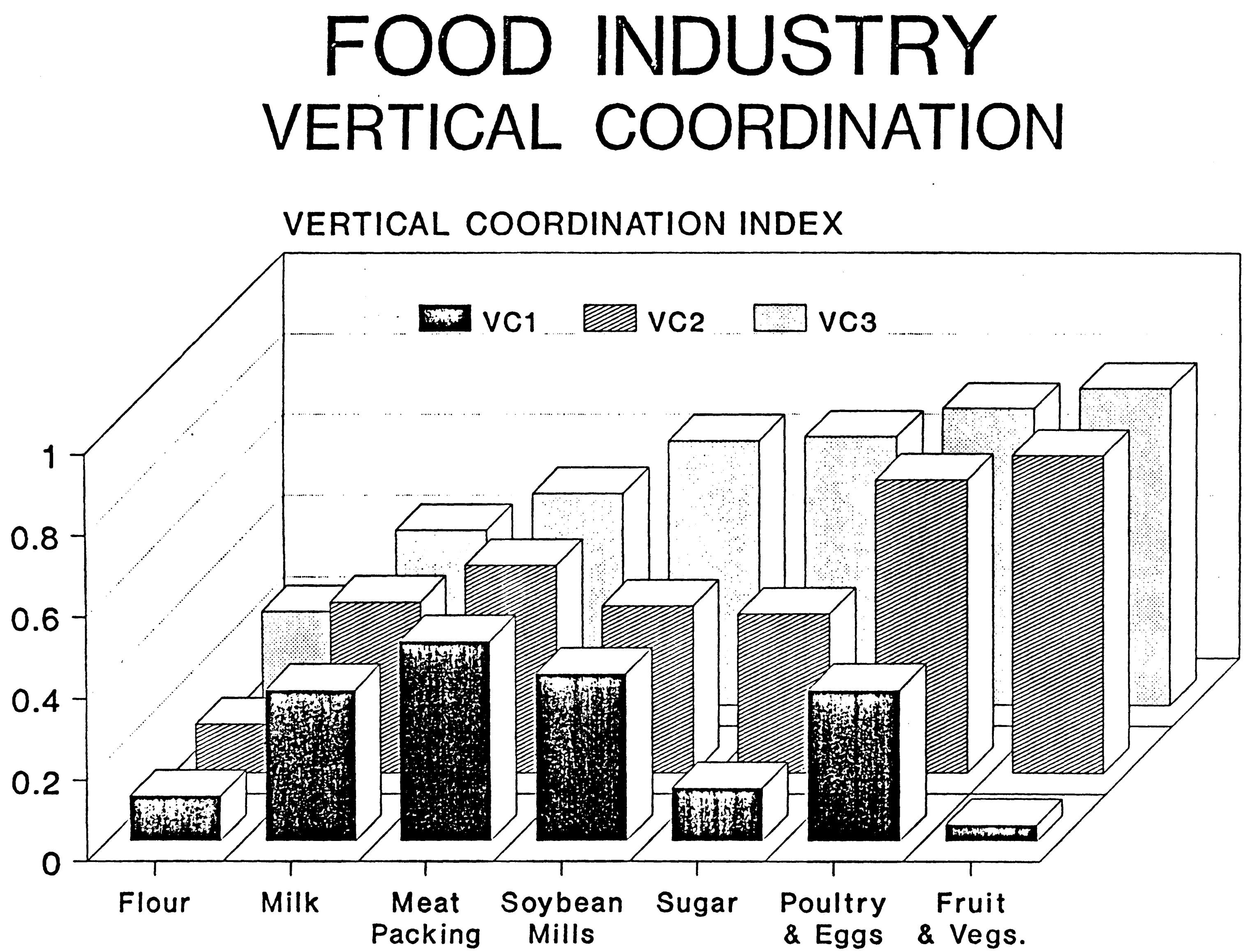


Figure 2. Food Industry Vertical Coordination

the use of governance contracts in coordinating production is apparent by examining the differences between VC1 and VC2, Figure 2. To illustrate, the average value of VC1 for the fruit and vegetable processing industries is 0.04 (Table 1). The industry's degree of vertical coordination as measured by VC2, which captures the importance of different contracts, averaged 0.78. It is then evident that the use of governance contracts as a means of coordinating production is critically important in the fruit and vegetable processing industry. Incorporating these different components (up and down stream connections and administrative control) in a progressive manner illustrates the importance of each and the robustness of the composite index (VC3) in measuring the level of vertical coordination in the food manufacturing industries.

To examine the effects of vertical coordination as a structural variable on the food manufacturing industries level of performance, several equations following the general form of equation 1 were analyzed,

$$1. \quad \text{export propensity} = (\overset{(+)}{VC}, \overset{(+)}{CR4}, \overset{(+)}{RD}, \overset{(+)}{KS}, \overset{(+)}{AS}, \overset{(+)}{PWHE}, \overset{(+)}{GDI})$$

with the expected signs above each variable. Variable descriptions and data sources are presented in Table 2.

It is hypothesized that vertical coordination, a structural variable, is positively related with export propensity, a measure of industry performance. As formulated, the vertical coordination index captures the amount of administrative control one industry exercises over another. With increasing industry vertical coordination, the industry's vertical production relationships are increasingly more efficient, allowing the industry to be more competitive. The remaining independent variables are all conventional measures used in market - structure - performance models. The concentration ratio, CR4, for each industry is a measure of market power. The two variables, RD and PWHE, are examined to account for the "technology" and "skill" factors. To account for possible trade barriers, the variables KS and AS are specified. The ratio of capital to shipments is a measure of financial barrier and the advertising-sales ratio is a proxy for the industry's product differentiation. Finally, a measure of the "tradability" of industry production is measured by the variable GDI.

In general, the regression results (Table 3) do not support the a priori effects of vertical coordination on export propensity. Specifically, three of the four vertical coordination variables, AVC, VC2, and VC3 are negatively and significantly related to the food industries' export propensity. The coefficients for RD, AS, and PWHE are also of opposite sign. Only the CR4, KS, and GDI variables are of expected sign. These findings suggest the food processing industries are applying the gains of increased efficiency from higher vertical coordination and skill levels to positively influence other measures of performance.

One possible consequence of greater vertical coordination is that efficiency gains therefrom have been captured as economic rents rather than used to expand sales into

## Table 1. Food Processing Industry Value of Vertical Coordination

| DESCRIPTION | AVC[a] | VC1[b] | VC2[c] | VC3[d] |
|---|---|---|---|---|
| Meat packing plants | 0.043 | 0.492 | 0.514 | 0.523 |
| Sausages and other prepared meats | 0.016 | 0.335 | 0.345 | 0.356 |
| Poultry dressing plants | 0.335 | 0.280 | 0.521 | 0.522 |
| Poultry and egg processing | 0.558 | 0.373 | 0.723 | 0.728 |
| Creamery buttery | 0.159 | 0.610 | 0.671 | 0.706 |
| Cheese, natural and processed | 0.159 | 0.495 | 0.575 | 0.575 |
| Condensed and evaporated milk | 0.121 | 0.367 | 0.444 | 0.519 |
| Ice cream and frozen desserts | 0.990 | 0.631 | 0.996 | 0.996 |
| Fluid milk | 0.083 | 0.367 | 0.419 | 0.427 |
| Canned specialties | 0.987 | 0.271 | 0.990 | 0.990 |
| Canned fruits and vegetables | 0.860 | 0.057 | 0.868 | 0.868 |
| Dehydrated fruits, vegetables, and soups | 0.793 | 0.017 | 0.796 | 0.798 |
| Pickles, sauces, and salad dressings | 0.914 | 0.160 | 0.928 | 0.930 |
| Frozen fruits and vegetables | 0.693 | 0.024 | 0.700 | 0.700 |
| Frozen specialties | 0.999 | 0.610 | 1.000 | 1.000 |
| Blended/prepared flour & other mill prods | 0.846 | 0.113 | 0.116 | 0.227 |
| Cereal breakfast foods | 0.539 | 0.368 | 0.709 | 0.709 |
| Rice milling | 0.001 | 0.163 | 0.164 | 0.169 |
| Wet corn milling | 0.000 | 0.124 | 0.125 | 0.357 |
| Dog, cat, and other pet food | 0.012 | 0.250 | 0.259 | 0.263 |
| Prepared feeds, n.e.c. | 0.013 | 0.399 | 0.407 | 0.665 |
| Bread, cake, and related products | 0.665 | 0.033 | 0.676 | 0.676 |
| Cookies and crackers | 0.000 | 0.093 | 0.093 | 0.093 |
| Raw & refined cane sugar and beet sugar | 0.303 | 0.128 | 0.393 | 0.663 |
| Confectionery products | 0.484 | 0.054 | 0.512 | 0.512 |
| Chocolate and cocoa products | 0.000 | 0.012 | 0.012 | 0.026 |
| Cottonseed oil mills | 0.004 | 0.145 | 0.148 | 0.148 |
| Soybean oil mills | 0.001 | 0.413 | 0.414 | 0.648 |
| Vegetable oil mills, n.e.c. | 0.001 | 0.384 | 0.384 | 0.562 |
| Animal and marine fats and oils | 0.000 | 0.009 | 0.009 | 0.157 |
| Shortening and cooking oils | 0.000 | 0.110 | 0.110 | 0.138 |
| Malt beverages | 0.003 | 0.257 | 0.260 | 0.260 |
| Malt | 0.000 | 0.251 | 0.252 | 0.596 |
| Wines, brandy, and brandy spirits | 0.373 | 0.031 | 0.392 | 0.392 |
| Distilled liquor, except brandy | 0.000 | 0.000 | 0.001 | 0.001 |
| Bottled and canned soft drinks | 0.000 | 0.033 | 0.033 | 0.033 |
| Flavoring extracts and syrups, n.e.c. | 0.000 | 0.033 | 0.033 | 0.145 |
| Canned and cured seafoods | 0.000 | 0.039 | 0.039 | 0.039 |
| Fresh or frozen packaged fish | 0.000 | 0.032 | 0.032 | 0.032 |
| Roasted coffee | 0.000 | 0.000 | 0.000 | 0.000 |
| Macaroni and spaghetti | 0.870 | 0.408 | 0.923 | 0.923 |
| Food preparations, n.e.c. | 0.807 | 0.468 | 0.897 | 0.899 |
| Mean | 0.301 | 0.225 | 0.426 | 0.476 |
| Standard Deviation | 0.371 | 0.193 | 0.328 | 0.318 |

a = vertical coordination, the up-stream adminstrative control
b = vertical coordination, up-stream connections
c = vertical coordination, up-stream linkages plus administrative control
d = vetical coordination, up and down-stream linkages plus administrative control

Table 2. Description of variables and data sources.

| Variable | Description |
|---|---|
| Export Propensity | The value of U.S. exports minus U.S. imports as a share of domestic value of industry shipments. Calculated from Census of Manufactures. |
| Profit Rate | A proxy for industry profits was calculated as industry value added minus the total payroll divided by the gross book value of depreciable assets. Calculated from the Census of Manufactures. |
| AVC | Vertical coordination, the up-stream administrative control. |
| VC1 | Vertical coordination using industry up-stream connections. Calculated from national input-output transactions matrix provided by Greg Alward. |
| VC2 | Vertical coordination using up-stream connections and administrative control. |
| VC3 | Vertical coordination using up-stream, down-stream connections, and administrative control. |
| CR4 | The four-firm concentration ratio, Census of Manufactures. |
| RD | The value of used research and development, private goods. Source; F. M. Scherer. |
| KS | The gross book value of depreciable assets to shipments ratio. Calculated from the Census of Manufactures. |
| AS | The value of advertising expenditures in the six measured media, from Leading National Advertising plus the value of industry advertising expenditures divided by industry shipments. Source; Richard Rogers. |
| MGMT | A proxy for management was calculated as the industry total payroll minus production worker payroll divided by the total payroll. Calculated from the Census of Manufactures. |
| PWHE | The average hourly wage for production workers. Census of Manufactures. |
| GDI | The geographic dispersion index to measure the tradability of production. See Collins and Preston. |

## Table 3. Determinants of U.S. Export Propensity, 1982

Dependent Variable = Export Propensity

| Equation | AVC | VC1 | VC2 | VC3 | CR4 | RD | KS | AS | PWHE | GDI | Constant | $R^2$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Regression Coefficients (t-values in parentheses) | | | | | | | | | | | | |
| 1 | $-0.14^{bb}$ | | | | $0.0029^{b}$ | -0.003 | 0.12 | | $-0.03^{a}$ | | $0.27^{bb}$ | 0.41 | 2.82 |
| | (2.17) | | | | (1.75) | (1.57) | (0.8) | | (2.03) | | (2.78) | | |
| 2 | | -0.19 | | | 0.0021 | | | -0.0023 | -0.24 | $0.097^{a}$ | $0.19^{aa}$ | 0.31 | 1.83 |
| | | (1.47) | | | (1.05) | | | (1.33) | (1.51) | (1.47) | (1.89) | | |
| 3 | | | $-0.21^{cc}$ | | 0.0022 | | | -0.00078 | $-0.035^{b}$ | $0.094^{aa}$ | $0.31^{cc}$ | 0.46 | 3.40 |
| | | | (2.848) | | (1.29) | | | (0.47) | (2.39) | (1.61) | (2.98) | | |
| 4 | | | | $-0.22^{bb}$ | $0.0025^{a}$ | | | -0.0016 | $-0.029^{a}$ | $0.097^{aa}$ | $0.28^{cc}$ | 0.47 | 3.53 |
| | | | | (2.93) | (1.47) | | | (1.06) | (2.07) | (1.67) | (2.86) | | |

Note: a, b, and c are significant at the .90, .95, and .99 level for a one-tailed test respectively.
aa, bb, and cc are significant at the .90, .95 and .99 level for a two-tailed test respectively.

## Table 4. Determinants of Food Industry Profits, 1982

Dependent Variable = Profit Rates

| Equation | AVC | VC1 | VC2 | VC3 | CR4 | KS | AS | MGMT | PWHE | Constant | $R^2$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Regression Coefficients (t-values in parentheses) | | | | | | | | | | | |
| 1 | $1.02^{b}$ | | | | $0.032^{c}$ | $-6.5^{cc}$ | | 1.35 | $0.22^{b}$ | -1.07 | 0.58 | 10.12 |
| | (2.49) | | | | (3.00) | (5.69) | | (0.94) | (2.16) | (1.32) | | |
| 2 | | -0.78 | | | $0.027^{b}$ | $-6.63^{cc}$ | | 0.68 | $0.2^{b}$ | -0.024 | 0.52 | 7.88 |
| | | (0.89) | | | (2.33) | (5.23) | | (0.44) | (1.85) | (0.028) | | |
| 3 | | | 0.55 | | $0.029^{b}$ | $-5.97^{cc}$ | $0.012^{a}$ | 1.14 | $0.14^{a}$ | -0.5 | 0.56 | 7.43 |
| | | | (1.12) | | (2.50) | (4.90) | (1.50) | (0.75) | (1.32) | (0.54) | | |
| 4 | | | | 0.53 | $0.028^{b}$ | $-6.04^{cc}$ | $0.014^{a}$ | 1.09 | 0.14 | -0.41 | 0.56 | 7.38 |
| | | | | (1.05) | (2.46) | (4.93) | (1.66) | (0.71) | (1.26) | (0.46) | | |

Note: a, b, and c are significant at the .90, .95, and .99 level for a one-tailed test respectively.
aa, bb, and cc are significant at the .90, .95 and .99 level for a two-tailed test respectively.

foreign markets. To examine this, several equations following the general form of equation 2 were analyzed;

$$2. \quad \text{profit rates} = f(\overset{(+)}{VC}, \overset{(+)}{CR4}, \overset{(+)}{KS}, \overset{(+)}{AS}, \overset{(+)}{MGMT}, \overset{(+)}{PWHE})$$

where the expected signs are above each variable and the description and data sources for each are identified in Table 2.

Industrial organization literature is rich with the impacts of market structure on industry profits. It is hypothesized that vertical coordination is positively related to profits. This arises because of the gains in production efficiencies. Based upon numerous studies by others, the variables CR4, KS, and AS are expected to be positively related to profits through increased market power and potential barriers to entry. Once again, the "skill" factor captured in the variables MGMT and PWHE are expected to positively affect industry profits.

The regression results for the profit equations (Table 4) generally support the hypothesized impacts. Specifically, the coefficients for the vertical coordination variables are quite enlightening. The coefficient for VC1, which captures the up-stream linkages, is negative, but not significant. However, the signs for VC2 and VC3 are positive, although not significant. This suggests that the component, up-stream governance contracts, which is captured in VC2 and VC3, but not in VC1, is a key factor influencing industrial performance and conduct. Indeed, this may be concluded. In equation 1, Table 4, the coefficient for AVC, up-stream administrative control, is significantly positive with food industry profit rates. Therefore, it appears that the food processing industries, through the increased use of governance contracts, is taking efficiency gains in terms of domestic profits rather than a higher level of exports.

## Summary and Implications

Structural characteristics have long been recognized as influencing industry competitive performance. Recently, growing concerns have centered upon the impacts of technological innovations on the structure and performance of the food and fiber sector. Studies have examined sources of market inefficiencies affecting industrial organization and performance. However, to the extent that vertical control was evaluated, those studies focused on vertical integration rather than the entire spectrum of governance structures used for vertical coordination.

In this paper we propose a measure of vertical coordination that incorporates governance structures used to coordinate the organization of production and vertical input-output interdependencies. The synthesis of the entire spectrum of vertical governance structures and input-output interdependencies into a single value provides an improved or more accurate representation of industrial vertical coordination.

Using this methodology, we quantified the effects of vertical coordination on two dimensions of market performance in the food and fiber sector. Specifically, hypotheses were tested concerning the relationship between vertical coordination, export propensity, and profit rates. Our initial findings suggest the food processing industries, through increased use of governance contracts, applied the gained efficiencies to profit taking rather than enhancing export market shares.

## Limitations

Although the functional form for vertical coordination encompasses the entire governance structure, its accuracy in measuring vertical coordination begs research in two areas. First, the value of transactions conducted under the various governance structures between interdependent sectors must be determined. Secondly, the degree of administrative control transferred under various forms of governance structures must be quantified.

Presently, sufficient data on the types of contracts utilized and the percentage of transactions conducted under each is available only in limited degrees for most agricultural subsectors. Each type of governance structure transfers some degree of administrative control from one stage to another. More complete and detailed information on the types of transactions and the value of output exchanged will improve the preciseness of the vertical coordination measure and thus improve its ability to explain differences in performance.

Finally, more needs to be learned regarding the extent to which managerial functions are transferred under various circumstances and contract formats. Quantifying the value of managerial functions and to what degree each is transferred can remove the subjectivity introduced in this study by assigning arbitrary cardinal values to administrative control. With such improved data, more definitive analysis of vertical coordination as a market structure variable will be possible.

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